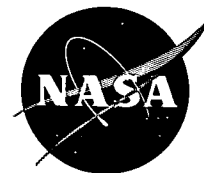
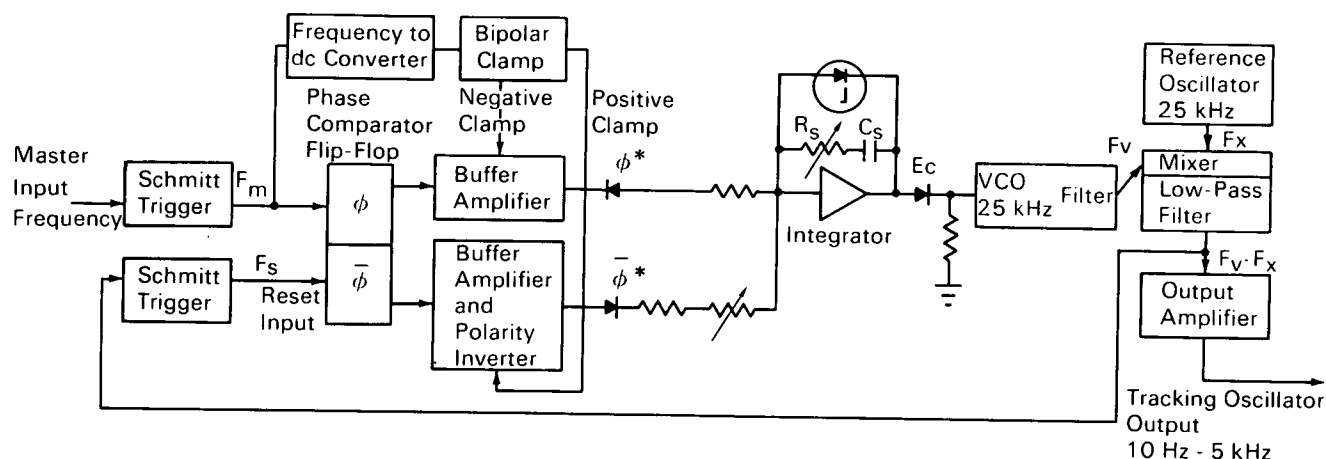


NASA TECH BRIEF



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Wide-Range Tracking Oscillator Generates Phase and Frequency Coherent Output



The problem:

To provide a stable frequency source capable of tracking an input frequency over a wide range. The frequency source must have the capability to track extreme input frequency fluctuations and must generate a phase and frequency coherent sinusoidal output with any periodic input waveform (i.e., pulse, square, sine, or triangular).

The solution:

A wide-range tracking oscillator consisting of a modified phase-locked loop which controls a voltage-controlled oscillator (VCO). The oscillator can automatically lock-on and track a periodic input waveform over a frequency ratio of 500:1.

How it's done:

A block diagram of the oscillator circuit, shown in the figure, consists of a modified phase-locked loop containing an operational integrator that drives a voltage-controlled relaxation oscillator. The filtered VCO output sine wave is heterodyned with a reference crystal-controlled sine wave in a mixer. A low pass

filter, following the mixer, extracts the difference frequency ($F_V - F_X$) and passes a sine wave which is squared and fed back to the phase comparator.

The phase comparator is a flip-flop (ϕ , $\bar{\phi}$) which is set for each cycle of the master input frequency (F_M), and reset for each cycle of the slaved tracking oscillator frequency (F_S). Buffer amplifiers, following the ϕ flip-flop, produce signals ϕ^* and $\bar{\phi}^*$, which swing from ground level to the negative and positive clamp levels while the flip-flop is set and reset, respectively. The clamp voltages are equal in absolute value, and are proportional to the frequency F_M , as determined by a pulse-counting frequency to dc converter. In effect, this lengthens the integrator time constant at low frequencies and maintains a constant amount of ripple on E_C , the integrator output voltage. Negative and positive currents from the clamped buffers are summed by the integrator. A clamp diode in the integrator feedback loop prevents integrator saturation and the $R_S - C_S$ network provides the necessary phase correction to prevent loop oscillations.

(continued overleaf)

If F_M and F_S differ in frequency, the duty cycle of ϕ^* and $\bar{\phi}^*$ is unequal, and the voltage E_C from the integrator drives the VCO in the direction that tends to equalize the duty cycle. When the duty cycle reaches 50%, the average value of E_C at the midpoint of its ripple becomes constant and the oscillator is locked to F_M . At this point, F_M and F_S are displaced in phase by 180° .

The natural condition of the phase-locked loop is a 50% duty cycle of the ϕ flip-flop and a 180° phase difference in F_M and F_S , regardless of how far the VCO deviates from its center frequency. The loop always has nearly 180° of phase to use in correcting itself before input frequency tracking is lost.

The prototype oscillator has a range of 10 Hz to 5 kHz, but the 500:1 ratio could just as well be 100 Hz to 50 kHz or any other part of the spectrum. It can also be used for frequency division or multiplication, and still generate a sinusoidal output.

Notes:

1. This tracking oscillator was designed to produce a clean sine wave from distorted accelerometer outputs, recorded during vibration tests of large vehicle parts. The cleaned-up, constant amplitude sine wave was then fed to a frequency-to-log dc converter to drive the x axis of an xy plotter for plotting G-level vs shaker frequency.
2. The wide-range tracking oscillator can be used in telemetry and communications systems where large signal fluctuations are encountered.
3. Requests for further information may be directed to:

Technology Utilization Officer
Marshall Space Flight Center
Code A&TS-TU
Huntsville, Alabama 35812
Reference: B70-10451

Patent status:

No patent action is contemplated by NASA.

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